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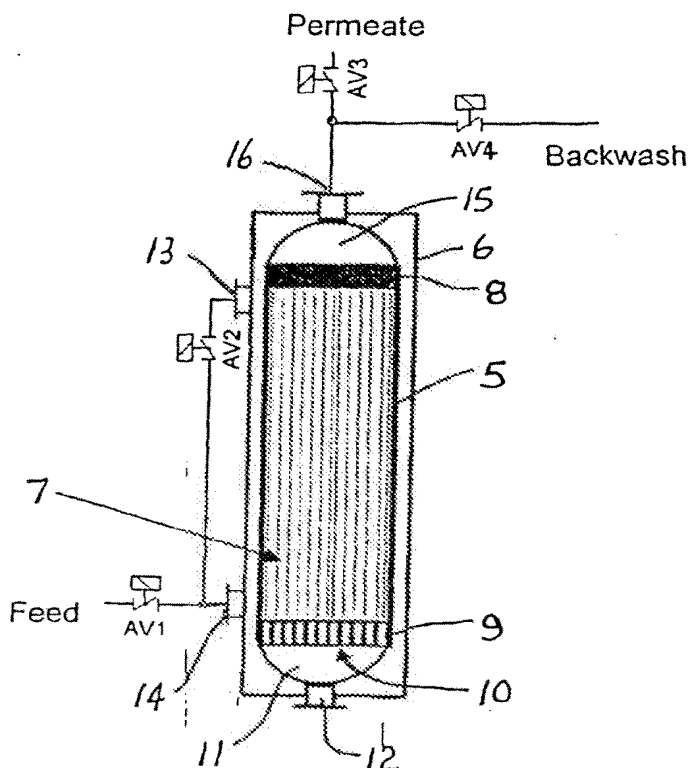
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(54) Title: HIGH SOLIDS MODULE



(57) Abstract: A method of cleaning a membrane filtration module (5) is disclosed. The module (5) includes at least one or more membranes (7) located in a feed-containing vessel (6) and extending longitudinally between vertically spaced upper and lower headers (8, 9) into which the ends of the membranes (7) are potted. The lower header (9) is not required in all cases and the membranes (7) may be suspended vertically from the upper header (8) only. The membranes (7) have a permeable wall which is subjected to a filtration operation wherein feed containing contaminant matter is applied to one side of the membrane wall and filtrate is withdrawn from the other side of the membrane wall. One or both of the upper and lower headers (8, 9) have one or more openings (10) therein. The method includes the steps of: suspending the filtration operation; performing a cleaning process on the membrane wall to dislodge contaminant matter from the membrane wall into liquid surrounding the membrane; performing a sweep of the feed-containing vessel (6) substantially parallel to the longitudinally extending membranes (7) to remove the liquid containing the dislodged contaminant matter, at least in part, through the openings (10) in the header (8, 9) or, where only the upper header (8) is used, through an opening (12) in the module, and then recommencing the filtration operation.

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TITLE: HIGH SOLIDS MODULE

FIELD OF THE INVENTION

The present invention relates to membrane filtration systems used with high solids feed and, more particularly, to a method and apparatus for improving the filtration efficiency of such systems by providing an improved cleaning system for the membranes.

BACKGROUND ART

In a membrane filtration process, the method used to physically clean membranes is of vital importance. An efficient membrane cleaning strategy can maintain a stable permeability of the membrane and reduce the frequency of chemical cleans. A commonly used method to physically clean membranes is a backwash (also called "backflush" or "backpulse") with the permeate/filtrate or a gas. The backwash method is typically used to eject solids blocking the membrane pores and partly dislodge the cake that may have formed on the membrane surface. In a system exposed to a feed containing a high concentration of solids, the fouling occurs more quickly and more severely, in particular, where membranes are densely packed in a module.

Backwash with pressurized gas has proved a very efficient cleaning method and is now widely used in the field of microfiltration processes. The limitation to this method is the membrane pore size. Backwash of membranes with permeate has no limitations to the pore size, but the backwash efficiency is generally lower than gas backwash and the transmembrane pressure (TMP) recovery not enough to offset the fouling rate. Further means are employed to enhance the backwash efficiency, such as dosing chemicals to the backwash permeate, or in combination with gas scrubbing.

Maruyama et al in Japanese Patent No. JP2031200 discloses a hollow fibre membrane backwashing method. The method involves the following sequence: stop filtration, air-scour membrane, fill the membrane vessel, backwash with permeate under pressurized air and drain the waste. This procedure is repeated to achieve a higher efficiency. Sunaoka et al in a United States Patent No. 5,209,852 describes a process for scrubbing hollow fibre membranes in modules. This process is composed of a two-stage air scrubbing and draining to clean the membranes.

In order to minimise footprint and cost, membrane modules are typically manufactured with a high packing density of membranes, usually in the form of fibres. This increases the amount of membrane area for filtration within a module. However, the higher the packing density the more difficult it is to effectively flush solids captured during the filtration process from the membrane bundle. Therefore, improvement in the efficiency of solids removal during backwash allows either higher solids levels to be processed, or higher membrane packing densities to be used, reducing the cost of treatment.

In prior art fibre membrane systems, removal of solids is usually effected by sweeping with feedwater from one end of the module to the other and then out of the module through a side exit port. In this case, solids are first swept along the fibres to the exit end of the module, but must then cross the fibre bundle to exit the module. In high solids applications this requirement for the flow to change direction and pass perpendicular to the fibre bundle to exit the module can lead to accumulation of solids near the exit due to the tendency for the fibres to act like a string filter and capture or hinder the exit of solids from the module at this point.

## DISCLOSURE OF THE INVENTION

The present invention seeks to overcome or at least ameliorate one or more of the disadvantages of the prior art or at least provide a useful alternative.

According to one aspect, the present invention provides a method of  
5 cleaning a membrane filtration module, said module including one or more membranes located in a feed-containing vessel and extending longitudinally between vertically spaced upper and lower headers into which the ends of the membranes are potted, the membranes having a permeable wall which is subjected to a filtration operation wherein feed containing contaminant matter is  
10 applied to one side of the membrane wall and filtrate is withdrawn from the other side of the membrane wall, at least one of said upper and/or lower headers having one or more openings therein, the method including:

- a) suspending the filtration operation;
- b) performing a cleaning process on the membrane wall to dislodge  
15 contaminant matter therefrom into liquid surrounding the membrane;
- c) performing a sweep of the feed-containing vessel substantially parallel to the longitudinally extending membranes to remove the liquid containing the dislodged contaminant matter, at least in part, through the openings in the header; and
- 20 d) recommencing the filtration operation.

For further preference, the openings are provided in the lower header and filtrate is withdrawn from the upper header. Preferably, the openings may also be used to introduce gas into the module to produce bubbles for scouring the surface of the membranes during said cleaning process. The sweep may be

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performed concurrently with the cleaning process. Preferably, the sweep is a high velocity sweep.

The present invention provides for holes or openings in one of the module pots so that solids swept along the membranes during the backwash process  
5 continue to flow parallel to the membranes as they exit the module. The requirement for the solids to cross over the fibre bundle to exit at a side port is substantially reduced or eliminated.

The same concept could be applied to submerged membranes operated in an open tank. In the prior art solids are typically removed by draining the  
10 tank. As the feed containing the solids drains from the module it must change direction near the bottom to flow out of the module and drain from the tank. By providing holes or openings in the bottom of the module, solids can continue to flow substantially parallel to the fibres as they pass out of the module. This uninterrupted flow provides for more efficient removal of solid from the module  
15 and tank.

According to a further aspect, the present provides a method of cleaning a membrane filtration module, said module including one or more membranes located in a feed-containing vessel and extending vertically from an upper header into which proximal ends of the membranes are potted, the membranes  
20 having a permeable wall which is subjected to a filtration operation wherein feed containing contaminant matter is applied to one side of the membrane wall and filtrate is withdrawn from the other side of the membrane wall, the method including:

- a) suspending the filtration operation;

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- b) performing a cleaning process on the membrane wall to dislodge contaminant matter therefrom into liquid surrounding the membrane;
- c) performing a sweep of the feed-containing vessel substantially parallel to the vertically extending membranes to remove the liquid containing the dislodged contaminant matter, at least in part, through an opening in the module beneath said membranes; and
- d) recommencing the filtration operation.

#### BRIEF DESCRIPTION OF THE DRAWING

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a schematic sectional view of a membrane module according to one embodiment; and

Figure 2 shows a schematic sectional view of a membrane module according to further embodiment.

#### DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the Figure 1, the filtration module 5 is mounted within a housing vessel 6 which contains the feed to be filtered. The filtration module 5 contains a bundle or bundles of hollow fibre membranes 7 extending between upper and lower headers 8 and 9, respectively. The lower header 9 is provided with a number of openings 10 communicating with the interior of the fibre bundle and a collection chamber 11 having an inlet/outlet port 12. Feed is supplied through ports 13 and 14 under the control of valves AV1 and AV2. Permeate/filtrate is withdrawn through chamber 15 and port 16 under control of valve AV3. A backwash may also be applied through port 16 under the control of valve AV4.

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In use, solids accumulated within the module 5 following filtration and backwash are flushed or swept from the module 5 through the openings 10 by opening port 12 and applying a suitable pressure to the feed within the module 5. Port 12 may also be used to supply gas to openings 10 to provide scouring  
5 bubbles within the module 5 to assist cleaning of the fibre membrane surfaces.

Figure 2 shows a similar arrangement to Figure 1, however, in this embodiment the hollow fibre membranes 7 are suspended vertically from the upper header 8 and are not potted at their lower distal ends 17. The distal ends 17 of each fibre membrane 7 are closed and filtrate withdrawn through the upper  
10 header 8. Backwash in this embodiment is flushed or swept through port 12.

It will be appreciated that further embodiments and exemplifications of the invention are possible with departing from the spirit or scope of the invention described.



## CLAIMS:

1. A method of cleaning a membrane filtration module, said module including one or more membranes located in a feed-containing vessel and  
5 extending longitudinally between vertically spaced upper and lower headers into which ends of the membranes are potted, the membranes having a permeable wall which is subjected to a filtration operation wherein feed containing contaminant matter is applied to one side of the membrane wall and filtrate is withdrawn from the other side of the membrane wall, at least one of said upper  
10 and/or lower headers having one or more openings therein, the method including:
  - a) suspending the filtration operation;
  - b) performing a cleaning process on the membrane wall to dislodge contaminant matter therefrom into liquid surrounding the membrane;
  - 15 c) performing a sweep of the feed-containing vessel substantially parallel to the longitudinally extending membranes to remove the liquid containing the dislodged contaminant matter, at least in part, through the openings in the header; and
  - d) recommencing the filtration operation.
- 20 2. A method according to claim 1 wherein the openings are provided in the lower header and filtrate is withdrawn from the upper header.
3. A method according to claim 1 or claim 2 further including introducing gas into the module through said openings to produce bubbles for scouring the surface of the membranes during said cleaning process.

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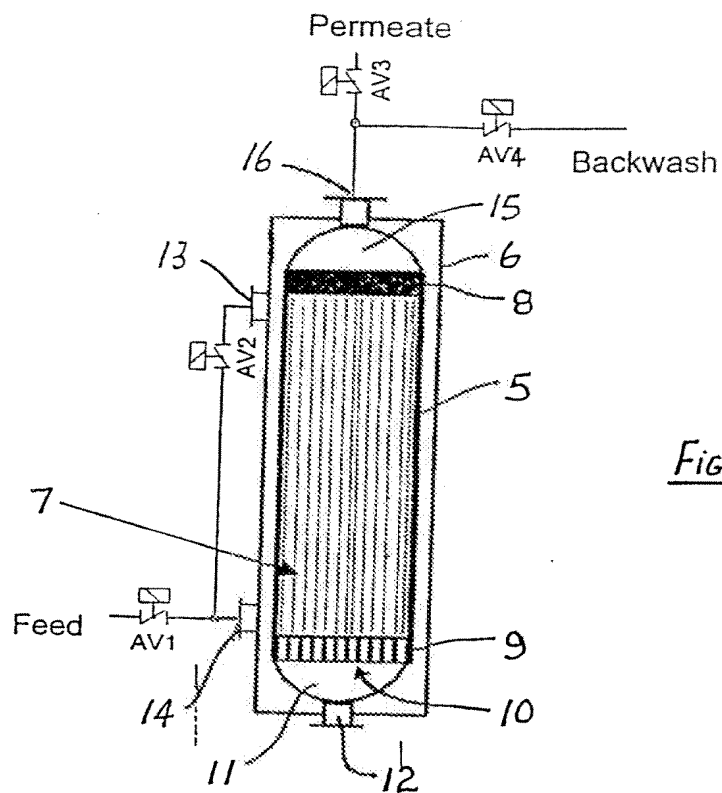
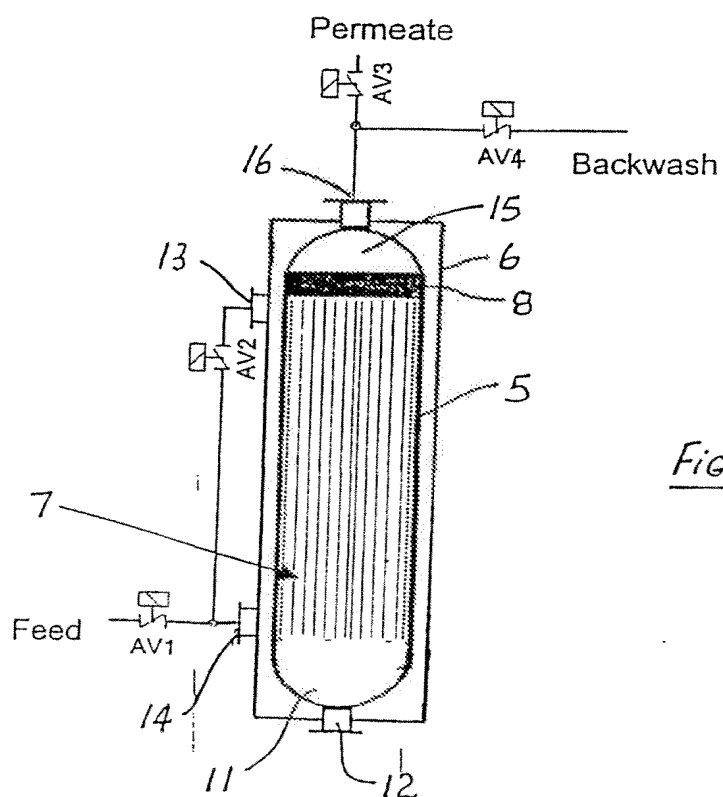
4. A method of cleaning a membrane filtration module, said module including one or more membranes located in a feed-containing vessel and extending vertically from an upper header into which proximal ends of the membranes are potted, the membranes having a permeable wall which is  
5 subjected to a filtration operation wherein feed containing contaminant matter is applied to one side of the membrane wall and filtrate is withdrawn from the other side of the membrane wall, the method including:

- a) suspending the filtration operation;
- b) performing a cleaning process on the membrane wall to dislodge  
10 contaminant matter therefrom into liquid surrounding the membrane;
- c) performing a sweep of the feed-containing vessel substantially parallel to the vertically extending membranes to remove the liquid containing the dislodged contaminant matter, at least in part, through an opening in the module beneath said membranes; and  
15 d) recommencing the filtration operation.

5. A method according to any one of claims 1 to 4 wherein the sweep is performed concurrently with the cleaning process.

6. A method according to any one of the preceding claims wherein the sweep is a high velocity sweep.

20 7. A method according to any one of the preceding claims wherein the sweep is produced by applying fluid under pressure to the feed-containing vessel.

Fig. 1Fig. 2

## INTERNATIONAL SEARCH REPORT

International application No.

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<b>A. CLASSIFICATION OF SUBJECT MATTER</b>												
Int. Cl. <sup>7</sup> : B01D 65/02												
According to International Patent Classification (IPC) or to both national classification and IPC												
<b>B. FIELDS SEARCHED</b>												
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched												
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DWPI: IPC + (SWEEP+ OR +BUBBL+)												
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>												
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.										
A	WO,A,200136075 (ZENON ENVIRONMENTAL INC) 25 May 2001 Whole document											
A	WO,A,9607470 (MEMTEC LIMITED) 14 March 1996 Whole document											
A	WO,A,9822204 (MEMTEC AMERICA CORPORATION) 28 May 1998 Whole document											
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex												
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td>"&amp;" document member of the same patent family</td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	"P" document published prior to the international filing date but later than the priority date claimed	
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"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone											
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"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family											
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Date of the actual completion of the international search 7 November 2002		Date of mailing of the international search report 1.3 NOV 2002										
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929		Authorized officer  <b>MATTHEW FRANCIS</b> Telephone No : (02) 6283 2424										

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU02/01272

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
WO 200136075		AU 200113764	AU 200113767	EP 1146954	
		EP 1146955	HU 200105236	PL 348909	
		US 6325928	WO 200136074	WO 200030742	
		AU 200012558	EP 1140330		
WO 9607470		AU 34661/95	CA 2199356	CN 1159769	
		EP 779835	US 6159373		
WO 9822204		AU 49361/97			
					END OF ANNEX